

design ideas

Edited by Bill Travis

Optocouplers are handy for motor drive

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FIGURE 1A SHOWS a latching circuit based on an optocoupler, IC₁. If the off switch remains closed, pressing the on switch powers the LED in the optocoupler. Thus, the transistor in IC₁ turns on. You can now release the on switch, and the transistor remains on. You must adapt the current-limiting resistor, R, to the power-supply voltage and the optocoupler's characteristics. To turn off this latch, press the off switch, thereby cutting the current path. The output of this circuit comes directly from the collector of the transistor. If you need an isolated output, you can use the circuit in Figure 1b, which works similarly to the circuit in Figure 1a. Figure 1c shows a similar circuit but with an NO (normally open) switch for both the off and on switches. Shorting the LED in IC₁ turns off the transistor in IC₁. Thus, IC₂ also turns off. Note that simultaneously pressing both the off and the on buttons turns on the output. But be aware that pressing the off button reduces the voltage across the circuit

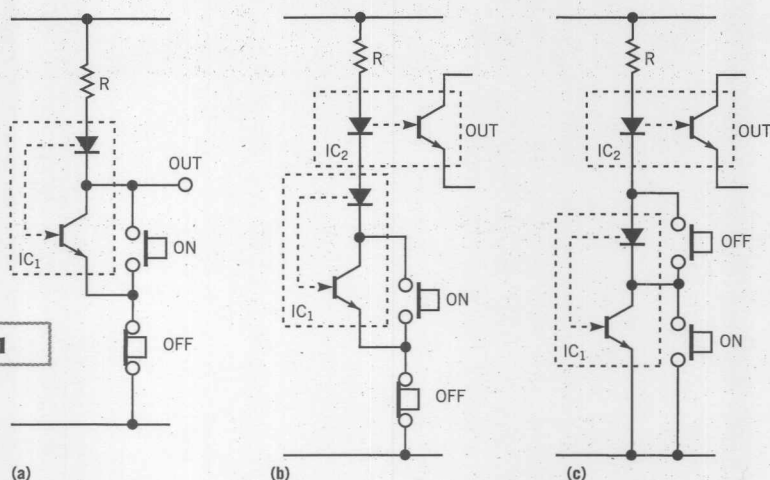
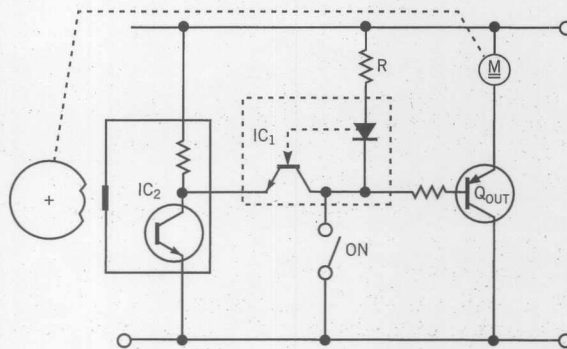


Figure 1

Various optocoupler-latching circuits are suitable for motor control. In (a) and the isolated circuit (b), simply pushing the on button turns on the circuit. In (c), you push both buttons simultaneously.

Figure 2



A notched cam controls a proximity switch, which determines the motor's stop positions.

below the resistor by 1 to 2V; you must consider this fact when you calculate the value of R.

Figure 2 is a simplified schematic of an application in which a motor must always stop at a defined position. "Simplified" means that it shows only the parts needed for illustrating the optocoupler's role

and omits protection, correct polarization, and a braking circuit, for example. IC₁ is the latching optocoupler. IC₂ is an npn-transistor, NO proximity switch. The proximity switch is on when metal is near its sensing area. A cam with a notch mounts on the motor axis. The motor should stop when the notch pass-

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es the sensing area of the proximity switch. Closing the on switch turns on transistor Q_{OUT} , thus allowing the motor to rotate, regardless of the status of the rest of the circuit. When you open the on switch, two things can happen:

- The notch is near the sensing area of the proximity switch. IC_1 and IC_2 are both off, so Q_{OUT} receives no base current. Therefore, the motor does not rotate.
- Metal is near the sensing area of the proximity switch, turning on the switch. The LED and, therefore, the

transistor, in IC_1 are still both on. Thus, the motor continues to rotate until the notch nears the sensing area of the proximity switch. At this point, the motor ceases to rotate.

All circuits were tested using a PC814 optocoupler from Sharp (www.sharp.co.jp). (The circuit in **Figure 2** has been running for a few months on several machines.) Optocouplers, such as the 4N33, with accessible transistor bases are more difficult to use in this application. Of course, these circuits cannot replace all relays. But they are convenient and effec-

tive in applications in which the current and voltage are in the range of optocouplers. (You can add some amplification by adding some power Darlington transistors.) The main advantages of these types of circuits are that they are low-power, have no mechanical noise, have no switch bounce, cost only about 50 cents, require no critical components, and measure less than 6×10 mm.

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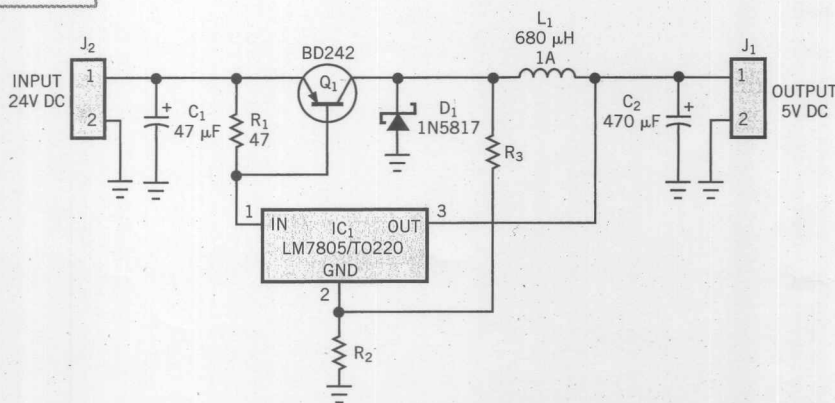
Linear regulator = low-cost dc/dc converter

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THE CIRCUIT IN **Figure 1** is a good choice if you need a power supply with high efficiency and you don't want to use expensive dc/dc-converter ICs. The heart of the circuit is IC_1 , the common, inexpensive LM7805 linear regulator. The external switch is a pnp transistor; the circuit can easily source more than 1A output current. As an additional feature, the switching circuit automatically turns off if the load draws no or only a few milliamperes of currents. Under these conditions, the circuit works as a normal linear regulator. When you first apply input voltage, current flows through resistor R_1 and through the LM7805 to the output. Current also flows through the emitter-base junction of Q_1 and turns on the transistor. The current through inductor L_1 now rises, and the output capacitor, C_2 , charges. When the output reaches the rated output of the linear regulator (5V for the LM7805), the regulator switches off its output.

Now, transistor Q_1 switches off, because the LM7805 cuts off Q_1 's base current. When the switch turns off, the voltage across the inductor changes polarity, and current flows through diode D_1 . The current delivers more charge to C_2 , until all the energy stored in L_1 transfers to C_2 . If a load is present at the output, the load

Figure 1



You can use a linear regulator in a switching circuit to configure an inexpensive dc/dc converter.

current discharges C_2 . When the output voltage drops a few millivolts below the 5V output voltage of the LM7805, the LM7805 again starts sourcing current to the load. This action switches on Q_1 , and the cycle starts again. Under light- or no-load conditions, all the output current flows through the LM7805, and Q_1 always stays off. You can adjust the switcher's start current by selecting the value of R_1 .

You can also use this circuit for output voltages greater than 5V. You can replace the LM7805 with an LM7812 or an LM7815 to obtain 12 or 15V at the out-

put. For these higher voltages, you should add resistors R_2 and R_3 . These resistors add some hysteresis to the circuit, reducing the switching frequency. Typical values are 2.2 and 2.2 k Ω , respectively. With the circuit in **Figure 1**, you can attain efficiency approximately of 75% when you convert 24V to 12V. If you use a 5V regulator, efficiency drops to 65%, but that figure is still better than that of a pure linear regulator.

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